# 16 GHz to 32 GHz, Tunable Band-Pass Filter

Data Sheet **ADMV8432**

## FEATURES

**Amplitude settling time: 200 ns typical**
**Wideband rejection: ≥30 dB**
**Single chip implementation**
**40-lead, 6 mm × 6 mm, RoHS compliant LFCSP**

## APPLICATIONS

**Test and measurement equipment**
**Military radar and electronic warfare (EW) systems**
**Video satellite (VSAT) communications**

## FUNCTIONAL BLOCK DIAGRAM

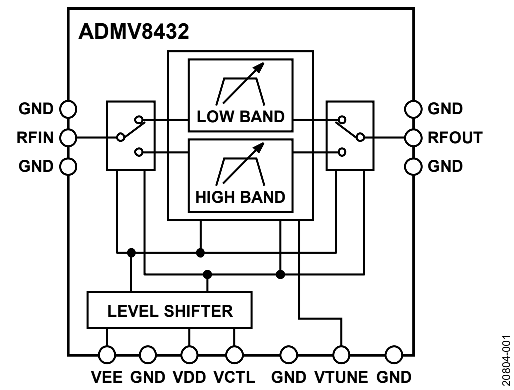


*Figure 1.*

## GENERAL DESCRIPTION

The ADMV8432 is a monolithic microwave integrated circuit (MMIC), tunable band-pass filter that features a user selectable pass-band frequency. The 3 dB filter bandwidth is >17% of the center frequency ($f_{CENTER}$). Additionally, $f_{CENTER}$ can be varied between 16.5 GHz to 29.5 GHz by applying an analog tuning voltage between 0 V to 15 V. This tunable filter can be used as a much smaller alternative to physically large switched filter banks and cavity tuned filters. This tunable filter has excellent microphonics due to the monolithic design and provides a dynamically adjustable solution in advanced communications applications.




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## REVISION HISTORY

**7/2019—Revision 0: Initial Version**

# SPECIFICATIONS

## HIGH BAND SPECIFICATIONS

$T_A$ = 25°C, VDD = 5 V, VEE = −5 V, and VCTL = 0 V, unless otherwise noted.

**Table 1.**

| Parameter | Min | Typ | Max | Unit | Test Conditions/Comments |
|---|---|---|---|---|---|
| FREQUENCY RANGE | | | | | |
| $f_{CENTER}$ | 24.2 | | 29.5 | GHz | |
| 3 dB Filter Bandwidth | | 17 | | % | |
| REJECTION | | | | | |
| Low-Side | | 0.75 × $f_{CENTER}$ | | GHz | ≥30 dB |
| High-Side | | 1.25 × $f_{CENTER}$ | | GHz | ≥30 dB |
| Re-Entry | | >40 | | GHz | ≤30 dB |
| LOSS | | | | | |
| Insertion Loss | | 9 | | dB | |
| Return Loss | | 15 | | dB | |
| DYNAMIC PERFORMANCE | | | | | |
| Input Third-Order Intercept (IP3) | | 37 | | dBm | |
| Input Power at 5° Shift in Insertion Phase | | 19 | | dBm | VTUNE = 0 V |
| Group Delay Flatness | | 0.1 | | ns | VTUNE = 0 V |
| Phase Sensitivity | | 0.6 | | Rad/V | |
| Amplitude Settling | | 200 | | ns | Time to settle to minimum insertion loss, within ≤0.5 dB of static insertion loss |
| Drift Rate | | −2.7 | | MHz/°C | |
| Tuning Sensitivity | | 580 | | MHz/V | |
| RESIDUAL PHASE NOISE | | | | | |
| 1 MHz Offset | | −162 | | dBc/Hz | |

## LOW BAND SPECIFICATIONS

$T_A$ = 25°C, VDD = 5 V, VEE = −5 V, and VCTL = 2.5 V, unless otherwise noted.

**Table 2.**

| Parameter | Min | Typ | Max | Unit | Test Conditions/Comments |
|---|---|---|---|---|---|
| FREQUENCY RANGE | | | | | |
| $f_{CENTER}$ | 16.5 | | 23.5 | GHz | |
| 3 dB Filter Bandwidth | | 18 | | % | |
| REJECTION | | | | | |
| Low-Side | | 0.72 × $f_{CENTER}$ | | GHz | ≥30 dB |
| High-Side | | 1.21 × $f_{CENTER}$ | | GHz | ≥30 dB |
| Re-Entry | | >40 | | GHz | ≤30 dB |
| LOSS | | | | | |
| Insertion Loss | | 8 | | dB | |
| Return Loss | | 10 | | dB | |
| DYNAMIC PERFORMANCE | | | | | |
| Input IP3 | | 34 | | dBm | |
| Input Power at 5° Shift in Insertion Phase | | 20 | | dBm | VTUNE = 0 V |
| Group Delay Flatness | | 0.15 | | ns | VTUNE = 0 V |
| Phase Sensitivity | | 0.8 | | Rad/V | |
| Amplitude Settling | | 200 | | ns | Time to settle to minimum insertion loss, within ≤0.5 dB of static insertion loss |
| Drift Rate | | −1.4 | | MHz/°C | |
| Tuning Sensitivity | | 530 | | MHz/V | |

| Parameter | Min | Typ | Max | Unit | Test Conditions/Comments |
|---|---|---|---|---|---|
| RESIDUAL PHASE NOISE | | | | | |
| 1 MHz Offset | | −163 | | dBc/Hz | |

## DC CHARACTERISTICS

Table 3.

| Parameter | Min | Typ | Max | Unit | Test Conditions/Comments |
|---|---|---|---|---|---|
| $f_{CENTER}$ TUNING | | | | | |
| Voltage (VTUNE) | 0 | | 15 | V | |
| Current ($I_{TUNE}$) | | | ±1 | μA | |
| BAND CONTROL VOLTAGE (VCTL) | | | | | |
| Input Voltage | | | | | |
| Low | 0 | | 0.8 | V | 0 V for high band select |
| High | 2 | 2.5 | 3 | V | 2.5 V for low band select |
| Current | | | 1 | μA | |
| SUPPLY VOLTAGES | | | | | |
| Negative (VEE) | −5.5 | −5 | | V | |
| Positive (VDD) | | 5 | 5.5 | V | |
| SUPPLY CURRENTS | | | | | |
| Negative ($I_{EE}$) | | 0.7 | | mA | |
| Positive ($I_{DD}$) | | | 1 | mA | |

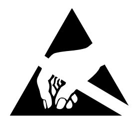
# ABSOLUTE MAXIMUM RATINGS

**Table 4.**

| Parameter | Rating |
|---|---|
| Tuning | |
| VTUNE | −0.5 V to +15.5 V |
| $I_{TUNE}$ | ±1 µA |
| Supply Voltages | |
| VEE | −5.6 V |
| VDD | 5.6 V |
| VCTL | −0.5 V to VDD + 0.5 V |
| RF Input Power | |
| 2 GHz to 50 GHz | 27 dBm |
| 0.5 GHz to 2 GHz | 19 dBm |
| 0.1 GHz to 0.5 GHz | 6 dBm |
| Hot Switch Input Power | |
| 2 GHz to 50 GHz | 24 dBm |
| 0.5 GHz to 2 GHz | 16 dBm |
| 0.1 GHz to 0.5 GHz | 3 dBm |
| Temperature | |
| Operating | −40°C to +85°C |
| Storage Temperature | −65°C to +150°C |
| Junction for 1 Million Mean Times Between Failures (MTTF) | 150°C |
| Nominal Junction ($T_{PADDLE}$ = 85°C, Input Power ($P_{IN}$) = 23 dBm) | 150°C |
| Electrostatic Discharge (ESD) Rating | |
| Human Body Model (HBM) | 250 V |
| Field Induced Charged Device Model (FICDM) | 1250 V |
| Moisture Sensitivity Level (MSL) Rating | MSL3 |

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

## ESD CAUTION



**ESD (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

# PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

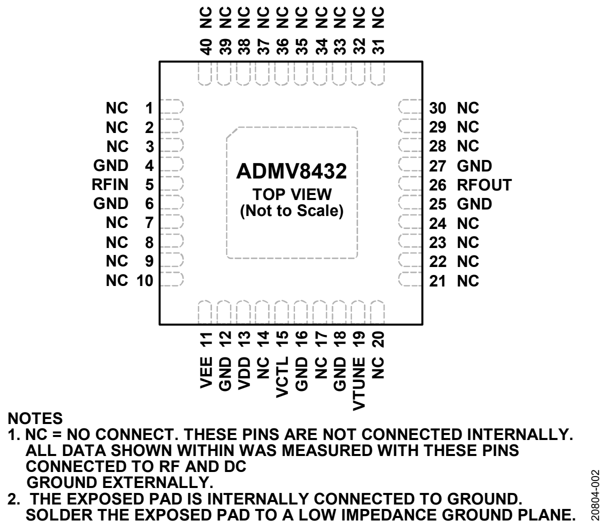



*Figure 2. Pin Configuration*

**Table 5. Pin Function Descriptions**

| Pin No. | Mnemonic | Description |
|---|---|---|
| 1 to 3, 7 to 10, 14, 17, 20 to 24, 28 to 40 | NC | No Connect. These pins are not connected internally. All data shown within was measured with these pins connected to RF and dc ground externally. |
| 4, 6, 12, 16, 18, 25, 27 | GND | Ground. These pins must be connected to RF and dc ground. |
| 5 | RFIN | RF Input. This pin is dc-coupled and matched to 50 Ω. Blocking capacitors are required if the RF line potential is not equal to 0 V. |
| 11 | VEE | Negative Supply Voltage. VEE is −5 V. |
| 13 | VDD | Positive Supply Voltage. VDD is 5 V. |
| 15 | VCTL | Control Voltage for Band Selection. The device is in the high band when the voltage is 0 V and in the low band when the voltage is 2.5 V. |
| 19 | VTUNE | Center Frequency Control Voltage of the Band-Pass Filter. VTUNE can be varied from 0 V to 15 V. |
| 26 | RFOUT | RF Output. This pin is dc-coupled and matched to 50 Ω. Blocking capacitors are required if the RF line potential is not equal to 0 V. |
| | EPAD | Exposed Pad. The exposed pad is internally connected to ground. Solder the exposed pad to a low impedance ground plane. |

## INTERFACE SCHEMATICS

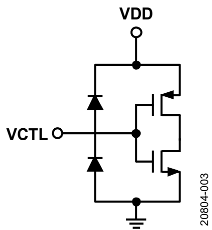



Figure 3. VCTL and VDD Interface Schematic

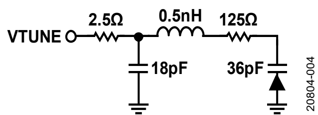



Figure 4. VTUNE Interface Schematic

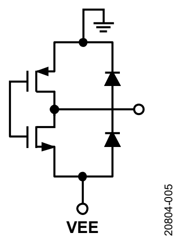



Figure 5. VEE Interface Schematic

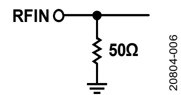



Figure 6. RFIN Interface Schematic

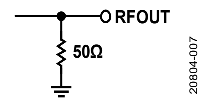



Figure 7. RFOUT Interface Schematic

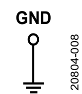



Figure 8. GND Interface Schematic

# TYPICAL PERFORMANCE CHARACTERISTICS

## HIGH BAND

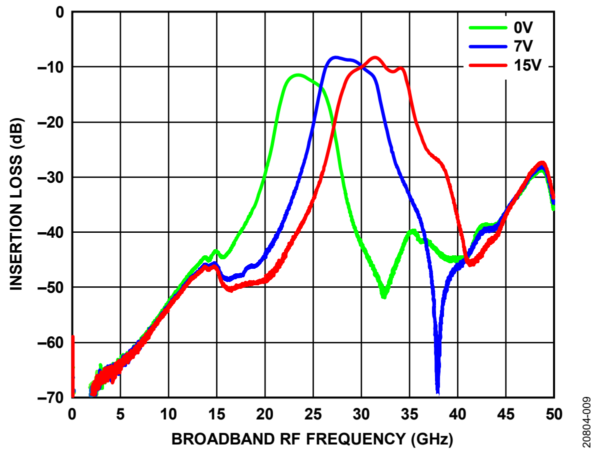



*Figure 9. Insertion Loss vs. Broadband RF Frequency at Various VTUNE Voltages*

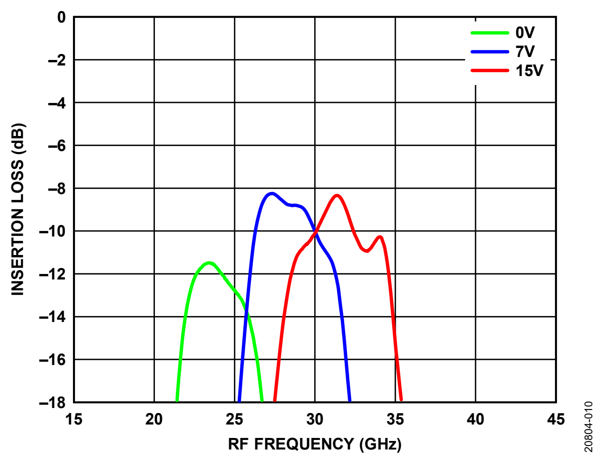



*Figure 10. Insertion Loss vs. RF Frequency at Various Voltages*

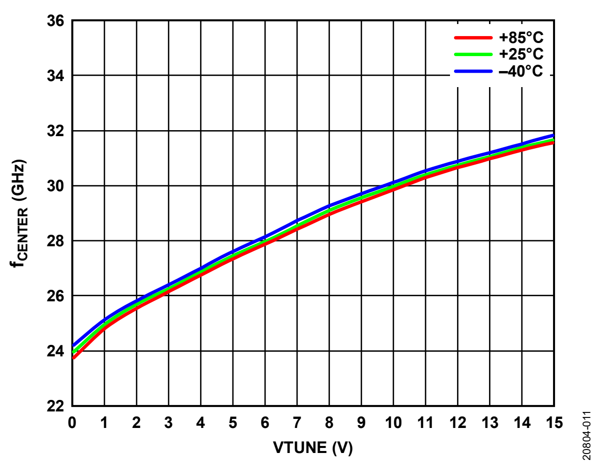



*Figure 11. $f_{CENTER}$ vs. VTUNE at Various Temperatures*

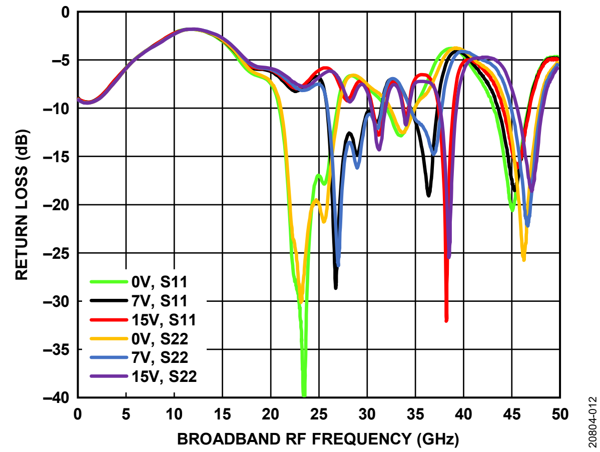



*Figure 12. Return Loss vs. Broadband RF Frequency at Various Voltages*

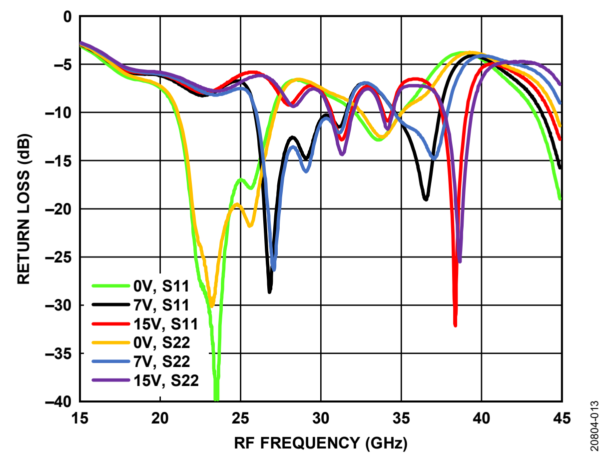



*Figure 13. Return Loss vs. RF Frequency at Various Voltages*

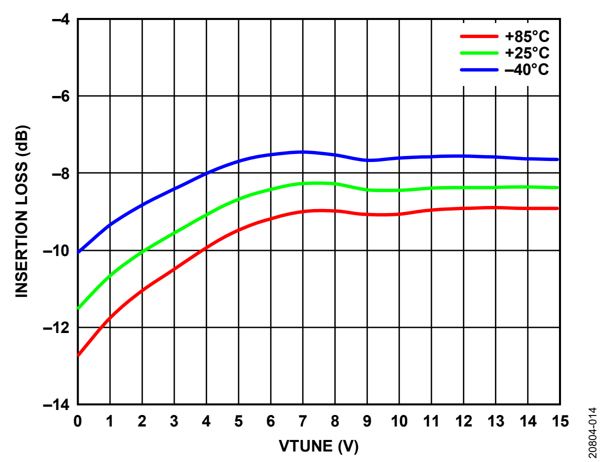



*Figure 14. Insertion Loss vs. VTUNE at Various Temperatures*

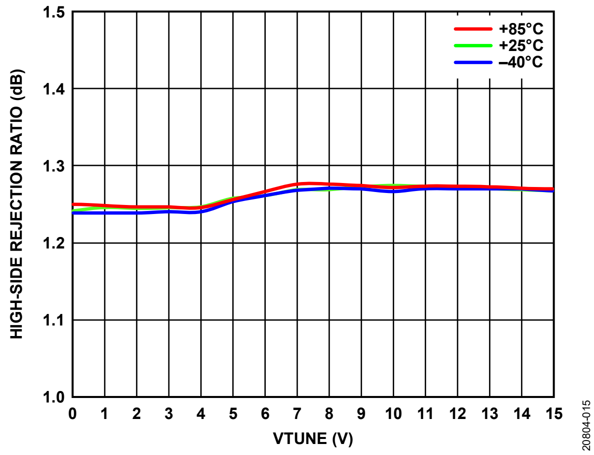


Figure 15. High-Side Rejection vs. VTUNE at Various Temperatures

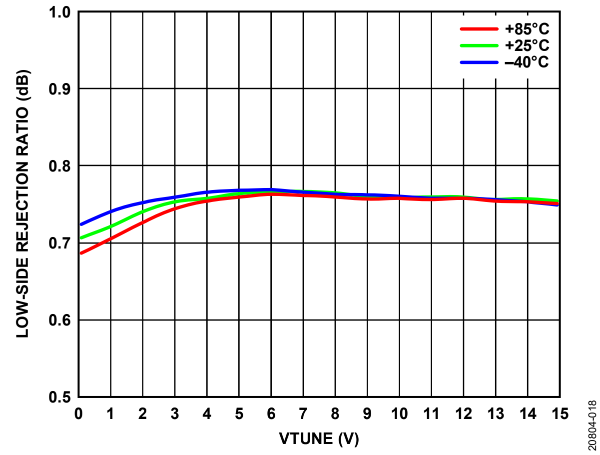


Figure 18. Low-Side Rejection vs. VTUNE at Various Temperatures

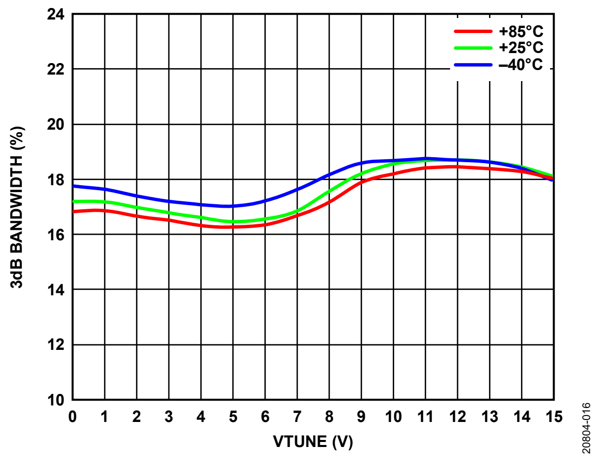


Figure 16. 3 dB Bandwidth vs. VTUNE at Various Temperatures

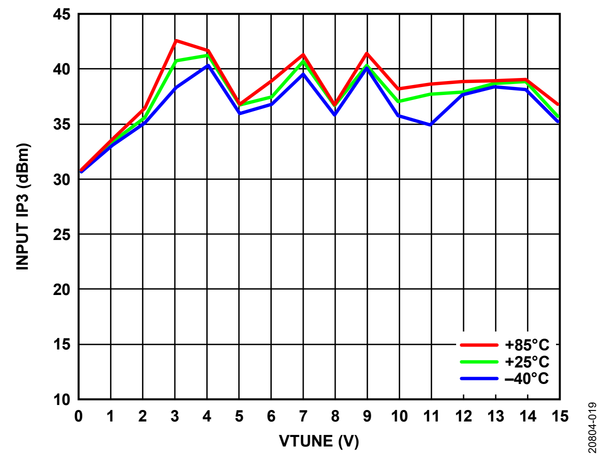


Figure 19. Input IP3 vs. VTUNE at Various Temperatures

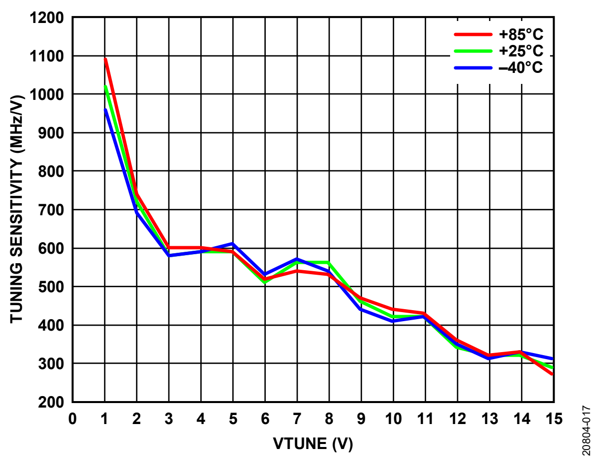


Figure 17. Tuning Sensitivity vs. VTUNE at Various Temperatures

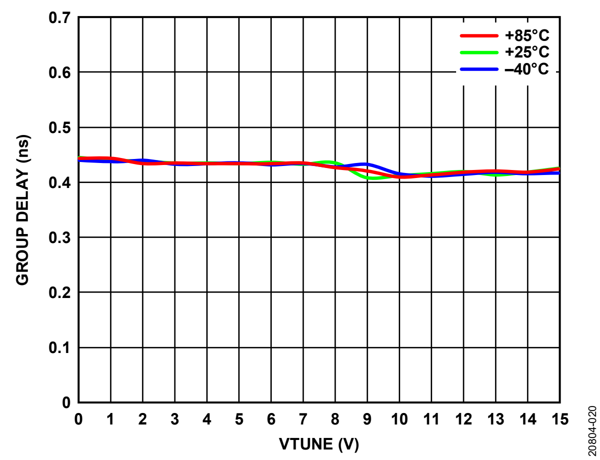


Figure 20. Group Delay vs. VTUNE at Various Temperatures

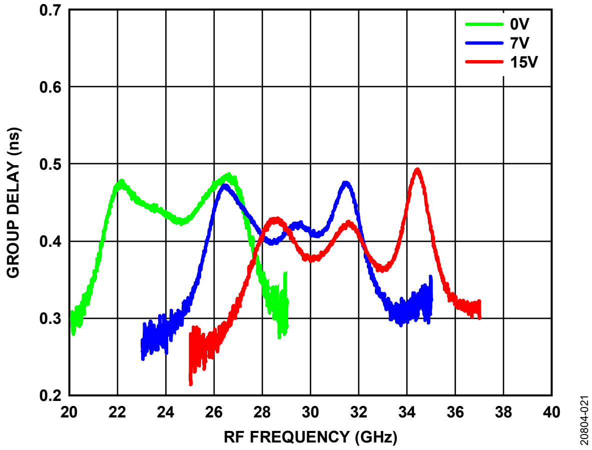



Figure 21. Group Delay vs. RF Frequency at Various VTUNE Voltages

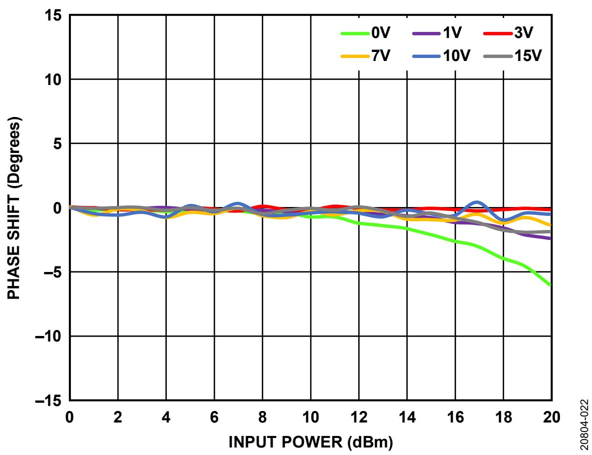



Figure 22. Phase Shift vs. Input Power at Various VTUNE Voltages

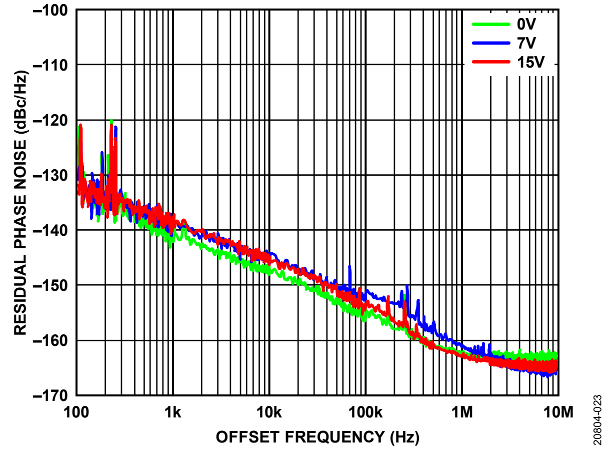



Figure 23. Residual Phase Noise vs. Offset Frequency at Various VTUNE Voltages

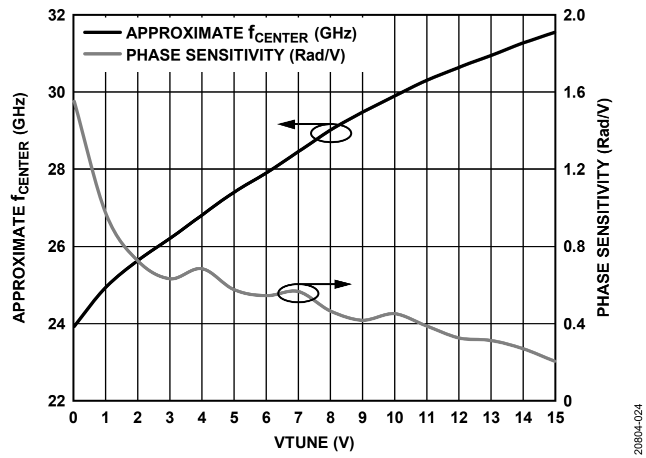



Figure 24. Approximate $f_{CENTER}$ and Phase Sensitivity vs. VTUNE

## LOW BAND

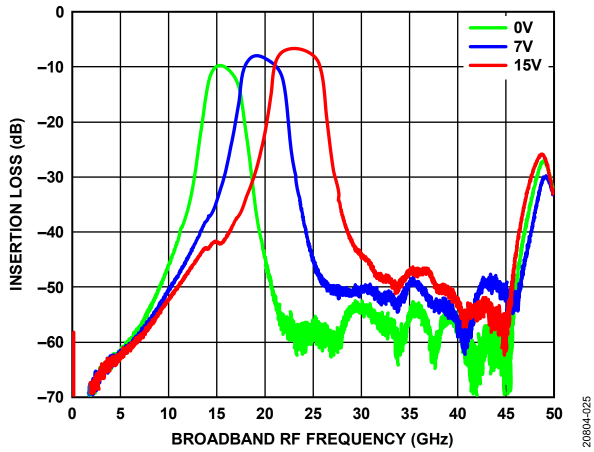



Figure 25. Insertion Loss vs. Broadband RF Frequency for Various VTUNE Voltages

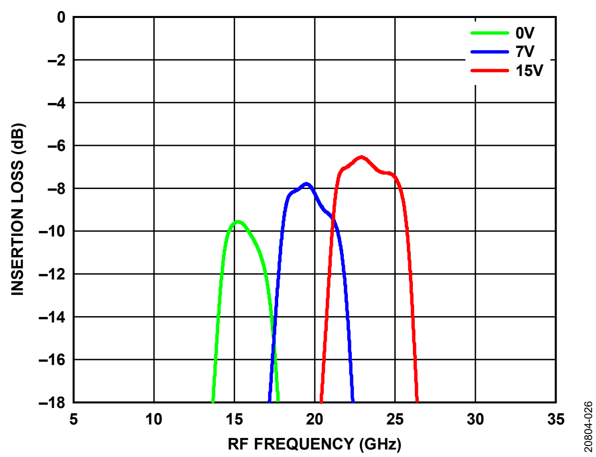



Figure 26. Insertion Loss vs. RF Frequency for Various VTUNE Voltages

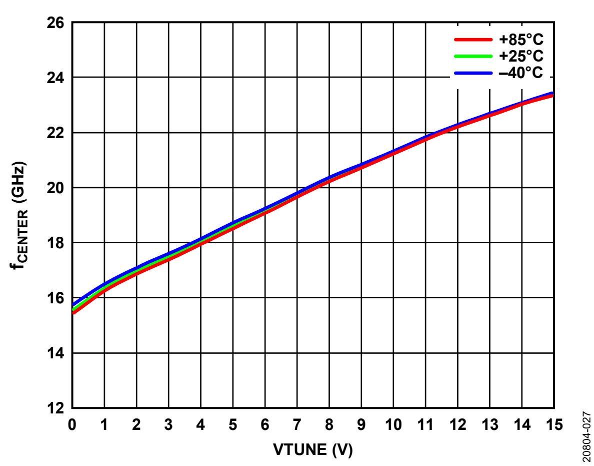



Figure 27. $f_{CENTER}$ vs. VTUNE at Various Temperatures

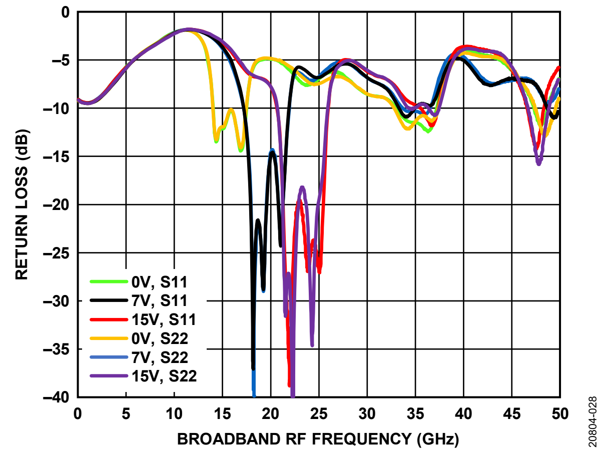



Figure 28. Return Loss vs. Broadband RF Frequency for Various VTUNE Voltages

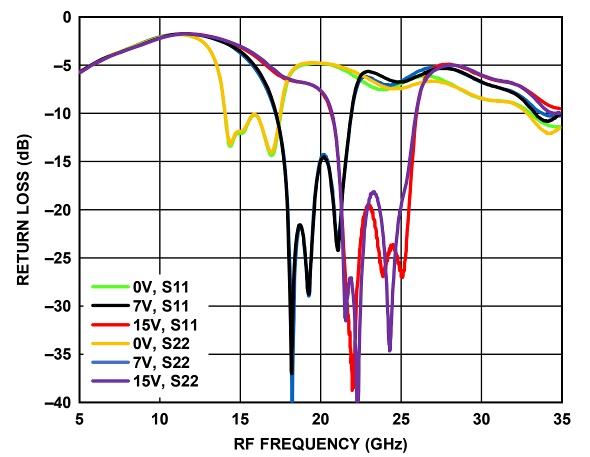



Figure 29. Return Loss vs. RF Frequency for Various VTUNE Voltages

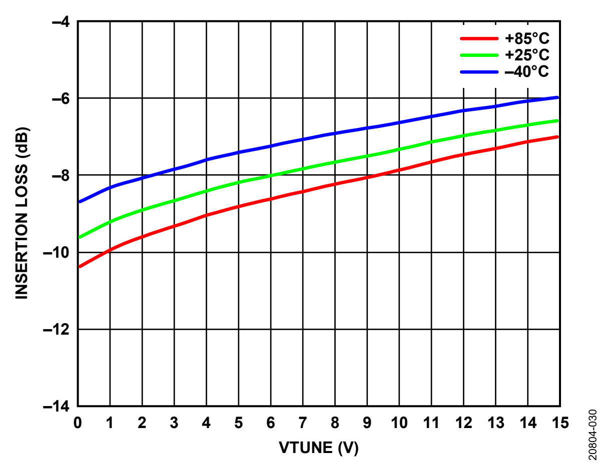



Figure 30. Insertion Loss vs. VTUNE at Various Temperatures

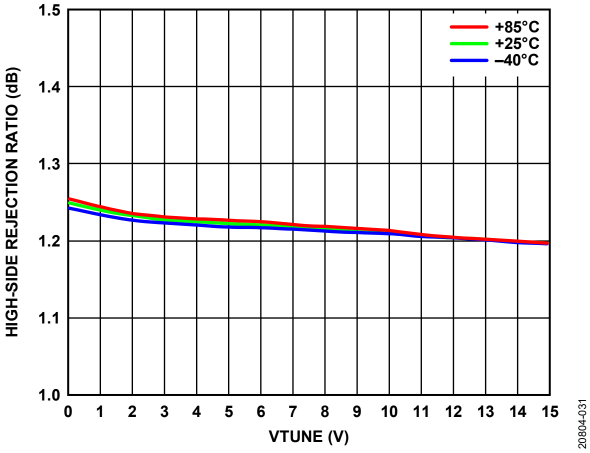


Figure 31. High-Side Rejection vs. VTUNE at Various Temperatures

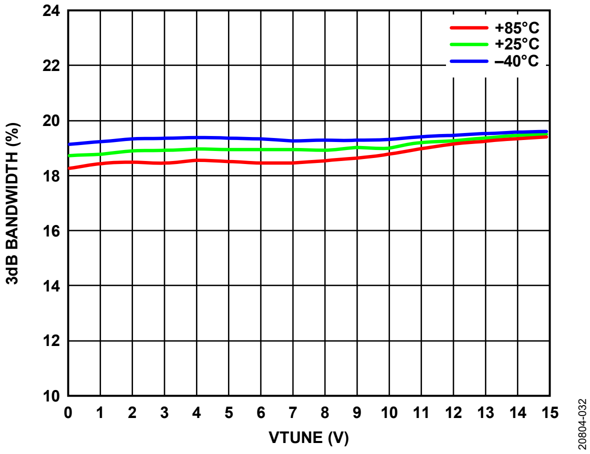


Figure 32. 3 dB Bandwidth vs. VTUNE at Various Temperatures

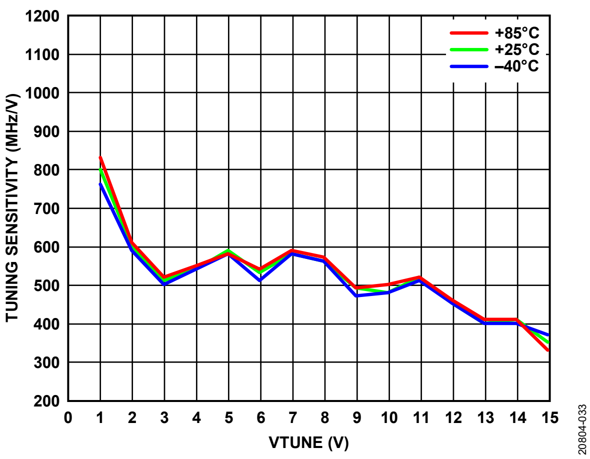


Figure 33. Tuning Sensitivity vs. VTUNE at Various Temperatures

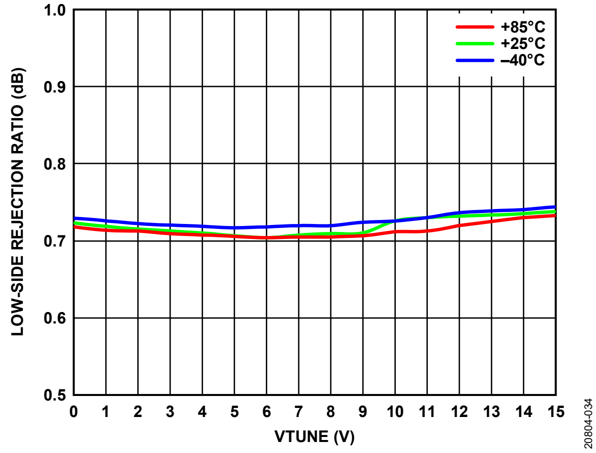


Figure 34. Low-Side Rejection vs. VTUNE at Various Temperatures

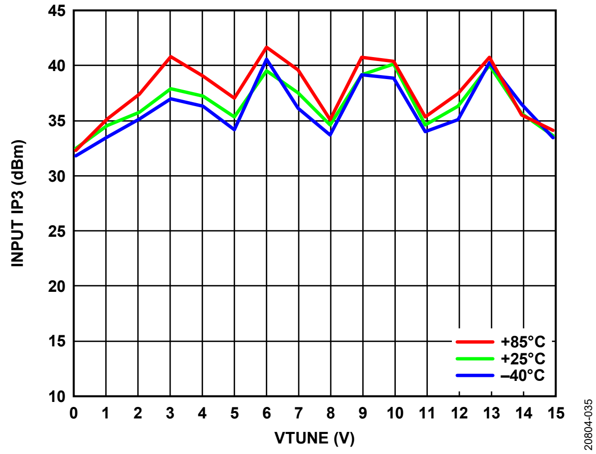


Figure 35. Input IP3 vs. VTUNE at Various Temperatures

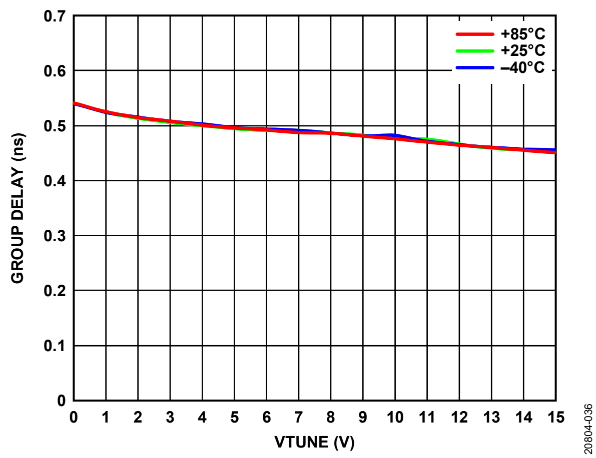


Figure 36. Group Delay vs. VTUNE at Various Temperatures

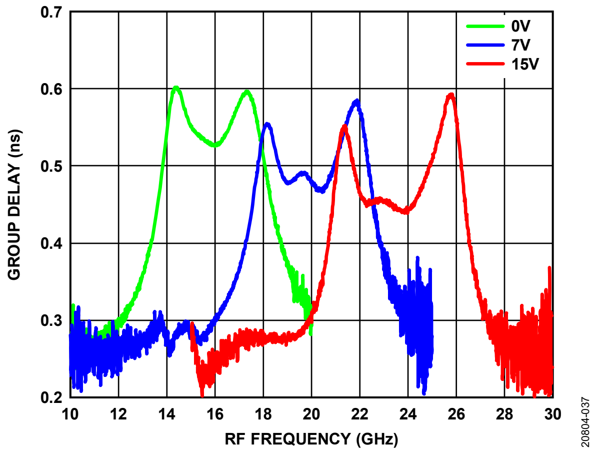



Figure 37. Group Delay vs. RF Frequency at Various VTUNE Voltages

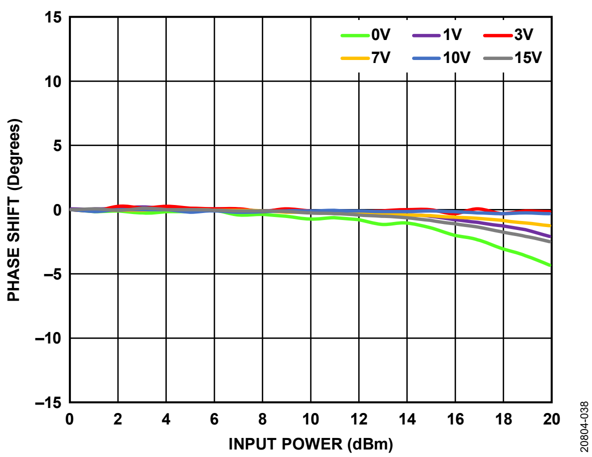



Figure 38. Phase Shift vs. Input Power at Various VTUNE Voltages

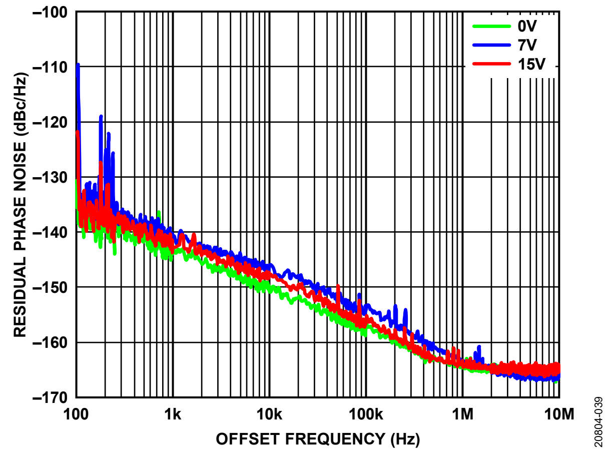



Figure 39. Residual Phase Noise vs. Offset Frequency at Various VTUNE Voltages

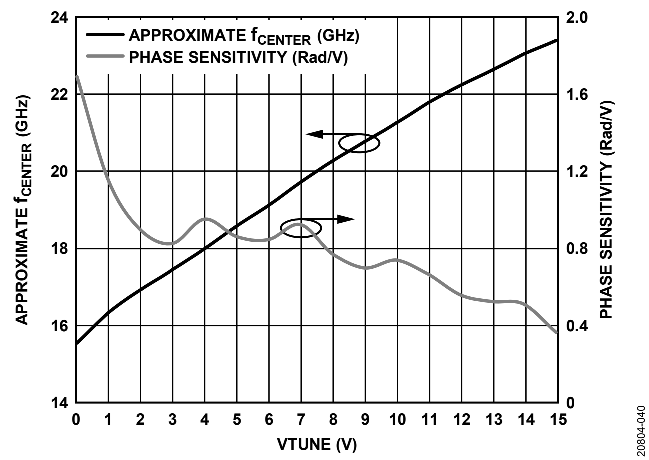



Figure 40. Approximate $f_{CENTER}$ and Phase Sensitivity vs. VTUNE

## HIGH BAND AND LOW BAND

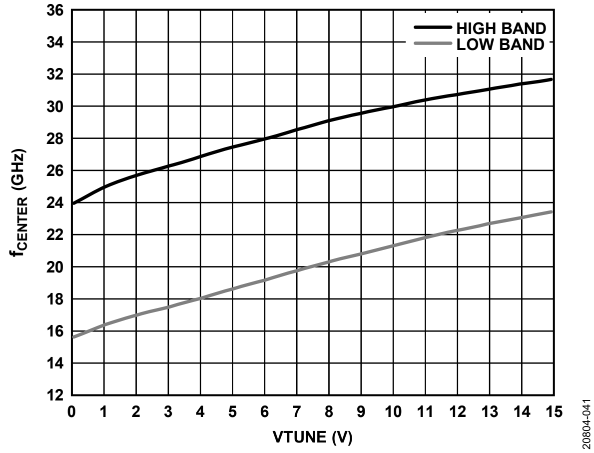



Figure 41. $f_{CENTER}$ vs. VTUNE

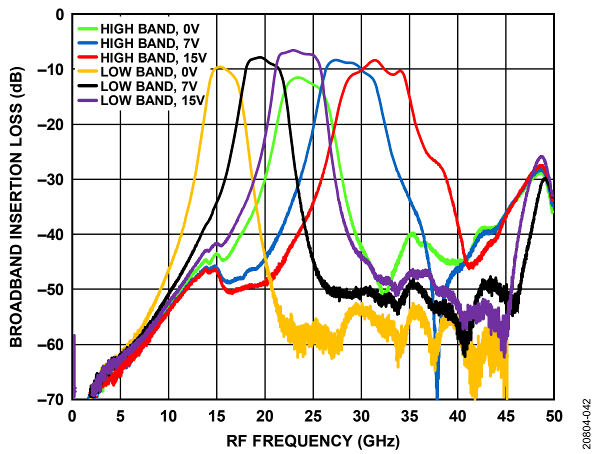



Figure 42. Broadband Insertion Loss vs. RF Frequency

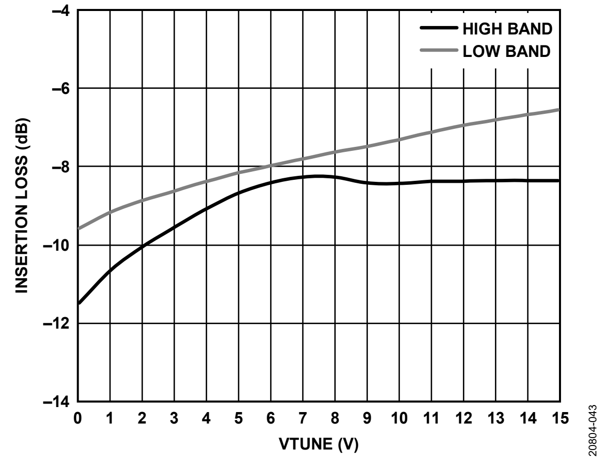



Figure 43. Insertion Loss vs. VTUNE

# THEORY OF OPERATION

The ADMV8432 is a MMIC, band-pass filter that features a user selectable pass-band frequency. To select the high band, apply 0 V at VCTL, and to select the low band, apply 2.5 V at VCTL. Varying the applied analog tuning voltage between 0 V and 15 V at VTUNE varies the $f_{CENTER}$ from 16.5 GHz to 23.5 GHz for the low band and from 24.2 GHz to 29.5 GHz for the high band.

# APPLICATIONS INFORMATION

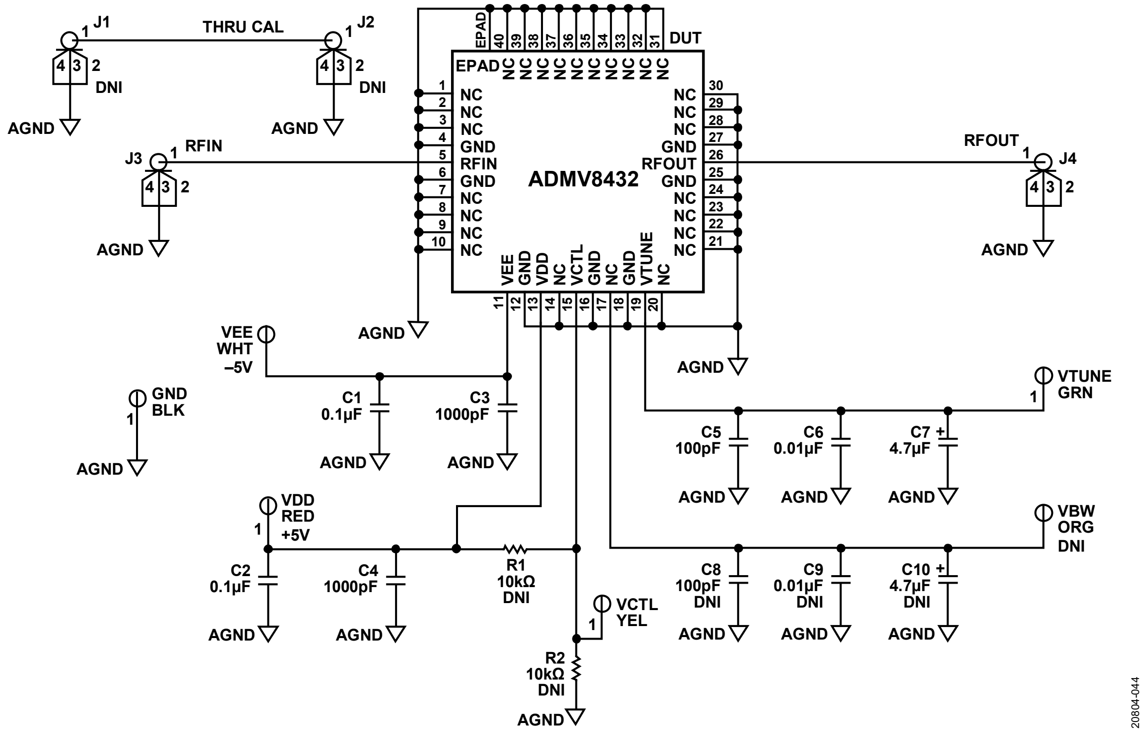



*Figure 44. Typical Application Circuit*

## TYPICAL APPLICATION CIRCUIT

Figure 44 shows the typical application circuit for the ADMV8432.

## POWER SUPPLY SEQUENCE

The required power-up sequence is GND, VDD, VEE, VCTL, and VTUNE. Deviations from this sequence may forward bias the ESD protection structures and damage them.

# OUTLINE DIMENSIONS

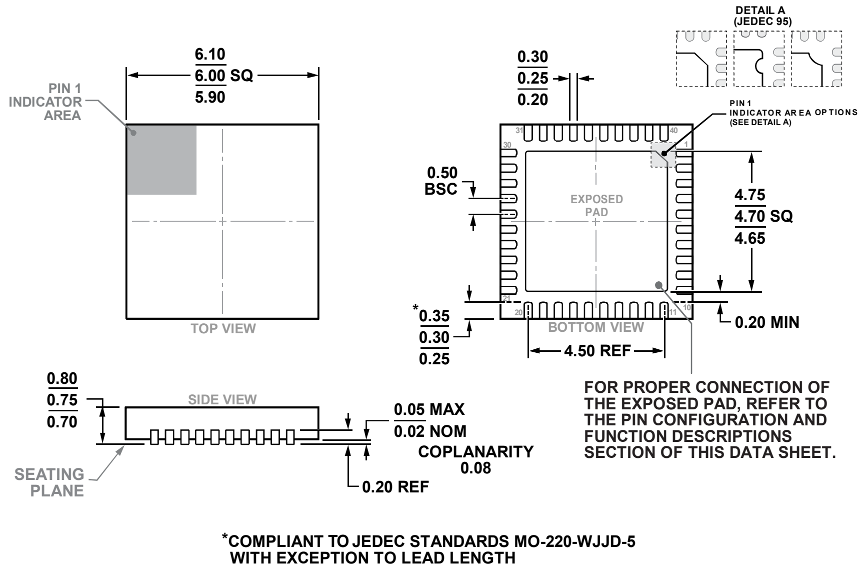



*Figure 45. 40-Lead Lead Frame Chip Scale Package [LFCSP]*
*6 mm × 6 mm Body and 0.75 mm Package Height*
*(CP-40-27)*
*Dimensions shown in millimeters*

## ORDERING GUIDE

| Model[1] | Temperature Range | Package Description | Package Option |
|---|---|---|---|
| ADMV8432ACPZ | −40°C to +85°C | 40-Lead Lead Frame Chip Scale Package [LFCSP] | CP-40-27 |
| ADMV8432ACPZ-R5 | −40°C to +85°C | 40-Lead Lead Frame Chip Scale Package [LFCSP] | CP-40-27 |
| ADMV8432-EVALZ | | Evaluation Board | |

[1] Z = RoHS Compliant Part.